COMPANY LEVEL LOGISTICS ON THE FUTURE BATTLEFIELD

A Monograph
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This monograph addresses the viability of current logistics units on future battlefields. The pace of modern warfare is changing as is the nature of the battlefield. To support combat operations in light of these changes, logistics units must adapt to the new environment. In the past American logistics units have been slow to change and adapt to the demands which were to face them in the future. With the pace of modern war this failure may be fatal in the future. The monograph reviews American logistics history and shows failures to adapt as well as highlighting one notable success occurring in the 1980's. The remainder of this paper analyzes the changes that are occurring on the battlefield and postulates how these changes will impact on logistics operations in the future. Several organizational changes and new technologies are highlighted that must be integrated into logistics systems of the next generation if they are to provide timely support to modern combat operations. Distributed logistics operations require a restructuring of traditional thoughts on battlefield structure and call for logistics units that can operate in a matrix over the battlefield instead of in traditional lines of support.

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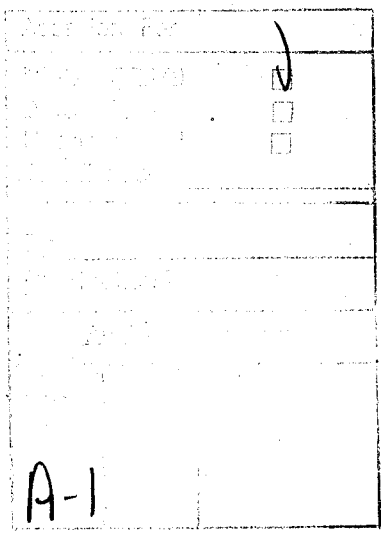

ABSTRACT

COMPANY LEVEL LOGISTICS ON THE FUTURE BATTLEFIELD by MAJ Timothy R. Coffin, USA, 59 pages.

This monograph addresses the viability of the current organization for logistics support to meet future battlefield demands. The pace of modern battle requires that American forces arrive on the future battlefield organized, trained and equipped to perform their missions. Past experience has shown that military organizations often do a better job of preparing for the last war than for the next. This critical examination of future needs provides a direction for logistics force development.

A review of the historical development of American logistics organizations shows little progress towards preparing logistics forces for future battlefields during most of our history. The traditional pattern was to disband our logistics apparatus at the completion of hostilities. The result of this short sightedness has been the failure of the logistics system to support the soldier on the battlefield at the outset of war. The first notable effort to prepare for the future came after the Vietnam War. This period, from the late 1970's into the 1990's, provides an example of the benefits accrued from preparing to provide logistics on the future battlefield. The preparations made for the hypothetical future battlefield in Europe were readily adaptable to the actual battlefield in Iraq.

This monograph examines the nature of the future battlefield to determine it's unique impact on the needs for logistics support, the ability of logistics forces to operate on it, and the impact of future battle systems on the nature of logistics operations. By examining trends in the development of the battlefield and using studies on the military applications of new technologies the paper is able to provide a picture of what future warfare may be like. The needs on this battlefield are contrasted against the capabilities of our current logistics system to provide support.

The fundamental conclusion of the paper is that it is time for a revolutionary change to battlefield logistics support. The current logistics system is adapted from the horse and buggy structure of the Civil War period and need to take advantage of current technologies to move into the Information Age. The future battlefield strips away the traditional protections that logistics forces have relied upon. Changes to equipment, organization, and doctrine are required for logistics to be effective in future operations. Distributed operations will require decentralized logistics structures that operate in matrix fashion over the battlefield to provide tailored support to combat forces.

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Introduction

"...it sometimes appears that the logistic aspect of war is nothing but an endless series of difficulties succeeding each other. Problems constantly appear, grow, merge, are handed forward and backward, are solved and dissolved only to reappear in a different guise....one sometimes wonders how armies managed to move at all, how campaigns were waged, and victories occasionally won."[1]

The challenge of providing logistics support on the battlefield is continually changing. The pipeline of materiel that links the nation's industrial strength with its soldiers on the front lines is subject to every friction and pressure of war. Too much friction and the pipeline is squeezed shut, reducing its flow to a trickle. Soldiers in combat are then hampered by the lack of supplies and pay in blood for the inability of the logistics system to meet their demands for food, ammunition, fuel and equipment.

With the tremendously high cost in human life of logistics un-preparedness it is inexcusable not to be prepared for future conflicts. The United States' ability to look into the future and organize logistics support units for the next war has been poor. A brief look at Army logistics performance in the past reveals a broken logistics system at the outbreak of war that is fixed as rapidly as possible with varying degrees of success. For our nation, the costs of un-preparedness have been great in terms of both resources and human suffering. While these costs were at times considered "affordable" in the past they can become un-affordable and lose the wars of the future. The relatively slow pace of American wars up through Vietnam

allowed our nation the luxury of reconstituting our logistics structure at the beginning of each conflict. Often the lack of logistics preparedness hampered the pace of operations early in the war, but, rarely did it result in the loss of the war.

In the future, military operations will be conducted at a much faster tempo than were the wars of our past. "Come as you are wars" do not allow for changes to doctrine, equipment, training, and manning after you arrive. Either they are right when the war begins or the war may be lost. General Douglas MacArthur said it aptly. "The history of failure in war can be summed up in two words: TOO LATE;..."[2] To avoid being "too late", it is important study the U.S. Army's past performance and that of other military's to detect weaknesses and strengthen them before they cause defeat.

Purpose

The Desert Storm war identified a myriad of vulnerable logistics points that need repair. The issues of transportation, ammunition, supplies and services, while not new, are normally buried far beneath the programs for new weapons systems when competing for defense budget dollars. With the congress and military's attention focused on these problems, some actions for modernization in the logistics arena have begun to be funded. Programs are now underway in many areas to bolster the strength of the logistics pipeline to meet the pressures that it faced in Iraq.

Some programs go beyond reflecting on the past and are charting a course to meet the demands of a future battlefield that does not yet exist. One area that has escaped the attention of logistics reform, but is critical to the future battlefield is the final link in the logistics system; where the soldiers, supplies and systems meet to produce combat power. This critical node of battlefield logistics requires

examination and reform before our combat and logistics forces will be ready to meet the challenges of the future battlefield.

This monograph examines today's organization for logistics support at this critical node, the U.S. Army, company level, and shows that the current structure is unable to support combat forces on the future battlefield. The thesis is that combat operations on the future battlefield will be so radically different from operations in the past, that they require a major restructuring of supporting logistics operations. This thesis is examined using historical examples, doctrinal requirements for performance and theoretical projections on the nature of future war. The results of this analysis are summarized in the conclusion with specific recommendations for changes to the structure of tactical logistics operations.

Logistics operations can easily be divided into the same three categories as the three levels of war. At the strategic level is the industrial base, the depot system and strategic transportation. Operational logistics take place within the theater of operations and include port activities, stockpiles and onward movement of supplies and equipment. Tactical logistics is the level of logistics support that takes supplies from the stockpiles and puts it in the hands of the user. This monograph concentrates on the portion of tactical logistics where logistics supplies transfer to the user on the battlefield. It is this tenuous link that sustains the soldier and allows him to continue the fight.

Battlefield Logistics

Today, grand logistics plans are developed to supply corps and divisions in war. In spite of these, the final link in the system is the privates and specialists who operate trucks loaded with fuel and ammunition. Their effort determines whether divisions and corps have the capability to move forward and fight. Three times a

day or more, often in the middle of the night, they meet tanks, howitzers and fighting vehicles low on fuel at some non-descript place where they may have never been before. If re supply is successful the Army Corps continues to move. If re supply fails the machines we fight wars with will freeze in place.

Battlefield logistics provides the combat soldier with the materiel he needs to fight and stay alive on the battlefield. It is a vulnerable link in the logistics system because it is provided on the battlefield in the face of enemy fires. To be effective, battlefield logistics must be responsive to the combat commanders needs. Fuel, ammunition, water and food must be provided quickly to troops in need, as near to the combat operation as possible.. The ideal system would provide the soldier the missile or round of ammunition just as he needs it without fail; this is not possible today or in the foreseeable future.

Since the logistics system is unable to provide "just in time delivery" of each round of ammunition or gallon of fuel, combat troops must carry sustaining supplies with them, weighting them down and reducing their flexibility to conduct combat operations. The longer the combat task force must operate without re-supply the heavier and less flexible it becomes. More frequent re-supply, then, becomes desirable if it does not take the combat force out of the fight. Today's heavy weapons systems have eight to twelve hours of independent operations in the armored task force before they require logistic support. After that amount of time the combat systems of a task force, most notably the M1 tank, have depleted their fuel reserves and must refuel and perhaps rearm before continuing combat operations.

Future Battlefield - American Evolution of Logistics Support

"...it should be remembered that organization is more often the product of tradition and policies and diplomacy and leadership than of clear-cut logic."[3]

To provide logistics on the future battlefield one must plan for it. The forces and equipment must be organized, trained and equipped with the future battlefield in mind, not the battlefield of the last war. While this appears to be simple logic, it is a truth that has often been missed in the past. Now it is even more critical than before. The pace of technological innovation and change means that the next battlefield will be less and less like the one that preceded it. Even when the battlefield was changing slower, the U.S. congress and military failed to perceive a need to prepare for the future battlefields. Looking at the past provides examples of how the United States has dealt with the problem of the future battlefield.

The Baseline - The Revolutionary War

The Revolutionary War, being our nations first war, is the baseline experience for Americans logistically supporting troops in the field. As our new nation struggled to create the institutions of state power, many deficiencies in planning and execution resulted in misery for the troops. The failures to support Washington's army during the American Revolution showed where improvement was needed and should have been the geneses for future war preparations. They were not. The suffering the troops endured were to be repeated again even though establishing a system to meet the needs of the next war would have required little insight into the changing nature of battle.

The Continental Army was characterized by the lack of an organized system for logistics support to the troops,[4] which resulted in shortages of clothing, food, transportation and ammunition. Clothing shortages were so acute during the Winter that "sentinels stood on their hats to protect their feet"[5] from the snow and ice. The sick in cabins set aside as hospitals laid on the bare poles of bunks without bedding, blankets or even straw.[6] Several times Washington's army ran out of food completely, as during the Winter at Valley Forge. On 25 May 1780 after the food supply had completely been exhausted for four days the Continental troops mutinied. At this point the need for food more than considerations of the enemy determined army movements[7]. Poor battlefield logistics had become the primary threat to the existence of the Continental Army, not the British.

On 14 May 1777 the Continental Congress authorized the appointment of an assistant deputy quartermaster general for each brigade.[8] While this gave one officer to each brigade for logistics, it provided no doctrine or overall system to support the combat forces. Using this war as a base line, the quality of logistics support could only go up. One would expect that this logistics debacle would be the source of many lessons for organizing logistics for future wars. This was most certainly not the case. With the independence of America secure, the authorized military strength plummeted at one point to "25 privates to guard supplies at Fort Pitt and 55 more to guard stores at West Point "and other magazines""[9] The office of Quartermaster General was abolished and with it, went the lessons learned on supporting troops in the field.

Indian Wars

With no plan for logistics support in place, U.S. troops entered the next conflict no better prepared that the last. Logistics support during the Indian wars

continued by default to be a contract affair with civilian outfitters. The 1790 and 1791 defeats of Harmar's and St. Clair's expeditions against the Indians in the Northwest Territory were caused, to a large degree by failures to support the soldiers logistically on the battlefield.[10] The evidence supports that in this hand to mouth supply environment that there was no serious thought given to establishing a systematic method of supply that would meet the needs of future battlefields.

The War of 1812

As expected the war of 1812 showed the neglect that had been shown to battlefield logistics in the previous years. "Subsistence supply failed so completely that field commanders found it necessary to take local food procurement virtually into their own hands in order to keep their commands intact."[11] Ironically the British troops found it easier to subsist in America off of local food stocks (because of superior logistics organization) than it was for the American troops. American troops on the northern frontier were destitute, disorganized and without any of the supplies that mattered. The failure of logistics support was a major factor in the loss of combat power. Again as the crisis passed no planning or structure was established for the logistics support of future wars.

Mexican War

During the War with Mexico in 1846 there was a clear vision for the organization that was needed to support battlefield logistics operations on the battlefield. General Jessup, observed that the lack of manpower in the field armies prohibited the accomplishment of logistics support. As a result civilian laborers were hired at higher cost and with a lower quality of work. Jessup proposed a corps of logistics workers that would be combat service support soldiers providing the

logistics needs of the army. His vision was more than sixty years ahead of his time. General Jessup's recommendations were rejected by Congress and lie dormant until World War I.[12] As a result the Mexican War closed with another piecemeal approach to logistics and no structure for the future battlefield.

The Civil War

In many ways the Civil War was a great logistics achievement. However, support to soldiers on the battlefield was not one of its strong points. No lessons from America's previous wars had been synthesized into designing a better system for the next war. Professional logistics leadership was almost non-existent on the battlefield[13] as was any military logistics structure. The structure to support logistics supply stopped at the regiment where one officer, one non-commissioned officer and the commander were responsible for all logistical support. Supplies coming from Army stocks were shipped directly to the brigade for distribution to the troops. From here ad-hoc procedures ruled the distribution of supplies.

> **"The men jealously watched the apportionment of their individual ration, with an especially anxious eye to see that they got their full share of coffee and sugar. In some units when the regimental quartermaster received a bag of coffee he carefully divided it for the ten companies. Then the orderly sergeant of each company had to divide his portion among all his men. A favored method was to spread two rubber blankets on the ground; on one the coffee would be poured in equal piles; at the same time the sugar ration would be divided in like fashion on the other blanket. Then everyone would march by and pick up one pile of each."[14]**

When the regiment needed to replenish its ammunition the ordnance sergeant would move a wagon "up as near as cover and concealment would allow, and the men carried the ammunition forward".[15] This is the same procedure that was used

from America's first war and without any vision for change continues on into the future.

Private teamsters provided most of the transportation support and were hired on the spot as needed. Independent civilian wagon operators were paid, by the load, for services rendered. Often this resulted in loads looted, lost, even dumped in the road when the trail got tough (a situation relived as recently as in Desert Storm more than 100 years later).[16] If a wagon owner received a better offer for his services, he would often empty his cart wherever he was and pick-up the new load, leaving the Army supplies by the side of the road.

Logistics trains were rarely far behind the troops they supported. Wagons would come forward with supplies on a pre-arranged basis or when signaled. After off loading supplies the wagons would take wounded soldiers back for medical treatment. The lack of protection for the wagons kept them away from the troops that needed the supplies. Fortunately at this time the logistic requirements during the battle were not as great as they soon were to become. Even so, logistics shortfalls on the battlefield resulted in many tenuous situations such as Chamberlain's critical shortage of ammunition at Gettysburg.

During the Civil War, protection for logistics supplies and operations was provided by linear fronts. Logistics supplies used distance from the front as their protection. The enemy lacked the intelligence capability to see and interdict logistics operations beyond the front lines with any regularity. This distance for protection also formed a significant problem between supported forces and their logistics support. Without a rapid means of communication logistics often failed to be responsive to the needs of the battlefield. Supported forces provided a screen of protection from detection and attack to the logistics support directly behind them. If an enemy attack was likely, the wagons and drivers would move back from the

battlefield to preclude capture or destruction by enemy artillery or cavalry forces. Further from the front, logistics wagons were susceptible to cavalry raids that could penetrate into interior regions.

The first line leader's only tool to lead his troops with was his natural equipment, his voice and his hands. The soldiers he led drove the wagons which were grouped together in a supply train to conduct their operations. The corporal directed his privates from his wagon or from the back of a riding mule depending on the unit's table of organization and equipment (TOE).

Even the greatest bloodletting in American history did not provoke the military to establish a logistics support system that could meet the army's needs on the future battlefield. A generation later , no significant changes to logistics support had been instituted and war was looming in Europe. The recognition that U.S. troops might become involved began to spawn questions as to how the troops would be supported. Military units were sketched with Tables of Organization but not manned. With the onset of World War I, logistics requirements increased slowly at first and then at an exponential pace. With greater demands on the system, the ad-hoc and piecemeal organization for logistics began to give way to a professional military force.

World War I

> **"The more I see of war, the more I realize how it all depends on administration and transportation...It takes little skill or imagination to see where you would like your army to be and when; it takes much knowledge and hard work to know where you can place your forces and whether you can maintain them there. A real knowledge of supply and movement factors must be the basis of every leader's plan; only then can he know how and when to take the risks with those factors, and battles are won only by taking risks."**[17]

World War I showed the beginning of a short range vision towards the problems of supplying combat troops on the battlefield. As the nation developed a professional military , a standing logistics system began to take shape. The responsibility for battlefield supply began to move from civilian contracts to military logisticians fulfilling General Jessup's dreams from more than sixty years earlier. Mechanization and modernization multiplied the requirements for logistics support to feed the battlefield. To meet the demands of "modern war" the wagon began to be replaced by the truck. As demands on the logistics system increased these trucks were replaced by larger, faster and more trucks. In the midst of this change, the basic nature of the logistics challenges remained the same; ever increasing demands for materiel, to be moved along insufficient routes, in all kinds of weather, with equipment that rarely was up to the challenge. The organization for battlefield logistics showed its first major change since the revolutionary war.

By 1914 published Tables of Organization begin to reflect field trains, combat trains, and supply companies (provisional). While the soldiers to man these organizations were still for the most part detailed from combat units this skeletal framework for was a first step in planning for the requirements of American troops on the future battlefield in Europe. Still, there was little vision in the army as to the enormous requirements for material that the next war would require for the front lines. Others, most notably the Russian writer Jean De Bloch, had a clear concept as to the nature of what the next major war would be like[18]. American logistics progress was substantial in light of its own history but was inconsequential as it was not focused on what the nature of future war would be like.

War on a grand scale in 1918 brought a paradigm shift to battlefield logistics demands. World War I was the first war in which the need for ammunition equaled the need for fodder[19]. The rapid introduction of new equipment like trucks and the

changing demands for logistics provided uncertainty and change. Experiences early in the war caused a major shift in logistics support forces. In 1917, battlefield support for deployed forces was laughably thin. In the Quartermaster arena. Pershing had sixteen quartermaster officers, ten enlisted men and twelve field clerks when he sailed for France. This support group was to provide or arrange for: transportation of personnel and supplies, repair to all vehicles of all services and organizations except military (tactical) vehicles, provide clothing, quartermaster equipment, subsistence, fuel, forage, lights, water, camp sites, quarters, offices and office equipment, pay and disbursements, laundries, bath, remounts, claims, salvage, workshops and storage, cold storage, refrigerating plants, labor, cemeteries and burials.[20] Logistics units were hastily organized to meet the demands and in the interim period U.S. allies had to support the American troops. Almost forty percent of the U.S. logistics units had to be organized in France from inexperienced personnel.[21] As a direct result of failing to prepare for the future battlefield in Europe, General John J. Pershing finally had to order five combat divisions disbanded to fill the need for logistics troops and replacements. By the end of the war, service troops consisted of thirty four percent of the total Army force[22] and for the first time in American history the bulk of logistics support on the battlefield was provided by military instead of civilian support.

Poor logistics support on the battlefield can be identified as one of the major reasons armies were unable to break out the trenches on the Western Front[23]. Lack of protection and limited mobility prevented logistics resources from maintaining the momentum of an attack. The new battlefield demanded additional protection in order to provide logistics support to forward elements engaged in combat. The response to this demand was an attempt to protect logistics supply on the battlefield with armor. Efforts began to develop a logistics supply tank. In spite of several

attempts to produce a vehicle that could move through enemy fire with impunity there was little success.

Leadership became more and more difficult to execute as mechanization changed the face of Army logistics. Not only were logistics troops required to use machines but the machines used in the supported combat units required fuel, ammunition, and repair support in excess of any levels ever required in the past. The period prior to World War I had marked a significant step in American logistics thinking. For the first time U.S. Army forces began organizing a military logistics force for support on the battlefield. Pershing identified several changes needed in the logistics organization to meet the needs of the army on the future battlefield. However, with the nation sick of war and in withdrawal from the international scene, Pershing's proposals fell on deaf ears. Logistics operations that had swelled to meet wartime demands were disbanded with the outbreak of peace.[24]

World War II

America entered World War II without a well designed logistics system. There was much thought between the World War I and World War II on how to break the stalemate of trench warfare but little thought on logistics. As a result the U.S. logistics system was not ready to support mobile battlefield operations. Army planners had failed to take into consideration the quantities of supplies now needed on the battlefield. They were staggering in comparison to the past. The lack of foresight resulted in many shortfalls in logistics organization. The logistics plan was capable of supporting the last war but not the next. Additional support units had to, again, be created from combat units to provide the logistic needs of the Allied Forces. To fill shortages, units arriving in theater were stripped of vehicles and drivers to create transportation and supply units.

In the period of 1940 to 1942 tactical units reorganized from "the big square" divisions to triangular divisions with three regiments each. In this reorganization all horse transportation was eliminated. Service elements in the division were stripped away with the intention that they would be provided by corps and army level elements.[25] After the fall of France, these changes, urged by General Pershing more than twenty years earlier, were finally adapted.

Changes to logistics units organizational structures reflected a new war with new problems to deal with. Logistics companies were required to operate over a larger area. Truck companies of 1942 were organized with two and a half times more first line leaders than the same type of unit just ten years before. The expanding battlefield required logistics operations to expand as well. To control expanded logistics operations, platoons and squads were subdivided into smaller sections with their own supervisor.

Logistics at the rifle company consisted of a supply sergeant, mess sergeant and several cooks. Every evening when the weather and enemy situation permitted, infantry companies would receive their re-supply from the back of jeeps pulling trailers. In the supply package soldiers received their food, water, batteries dry socks and ammunition. Ammunition was also available in the battalion supply point to provide back-up support around the clock. When the weather or enemy prohibited the jeeps from reaching the troops headquarters platoons and reserve companies were tasked to be the human mules to ferry supplies, through the mud and ruts, between the rocks, rain and enemy fire, to the front.

Korea/Vietnam

The end of World War II again brought turmoil to logistics organizations. Many units were adapted to provide support to occupation forces. Unit organization

tables were affected by the glut of senior grade personnel. By 1948, ordnance and quartermaster companies in infantry divisions had as many officers in them as they'd had corporals during World War II.

The Cold War with its rapid hot start in Korea was a reminder of the need for future logistics planning . In Korea the most difficult link in the logistics chain was that of getting the supplies that last few miles to the front line where the soldiers needed them. The jeeps and 2 $^1/_2$ ton trucks were unable to traverse the difficult terrain. Once again the only solution to this logistics system shortfall was the organizing of carrying parties to bring supplies to the front lines. This time the carriers were local national civilians who were hired to take the place of U.S. troops.[26] Logistics units reverted back to the basically the same organizations that were in place at the end of World War II.

In Vietnam the logistics support provided to company combat units required new techniques. Aerial re-supply solved many of the time/distance problems and allowed rapid re-supply and reinforcement of committed combat units. At the same time grade inflation had crept into the system and the corporal's role as a leader in low level logistics organizations had been replaced by the sergeant. By 1973 at the end of the Vietnam War, relatively minor changes to organization were reflected in TOEs, from those ten years before. Radios communicated requirements almost instantaneously and aviation support provided responsive support with great agility. Aircraft, with their radios and speed, could be diverted in flight to redirect priorities and influence the dynamics of a battle to change its outcome. Armored combat vehicles and trucks enabled ground re-supply to forward troops in contact. Superior firepower was used to suppress enemy weapons. Gun trucks, fortified with armor plates and sandbags, provided protection to logistics convoys and re-supply operations.

While many lessons were learned from our involvement in Vietnam few were carried over into future army supply operations. For once the army set aside its experience in the last war and began structuring its force on what the future battlefield was expected to look like. Its vision of the future saw armored units battling for Europe. The lessons from the jungle seemed not to apply. It was this vision that birthed the army's logistics system as we know it today. While the vision appears to have been flawed in that there has not been a major ground war it Europe, it served us well in meeting the needs of the Gulf War. This illustrates that one's concept of the future battlefield need not be with 20/20 vision to be useful, close may be good enough.

Summary

> **"It helps, in projecting...ahead 15-20 years to look at the past. Command and control history is one of steady evolution interspersed with abrupt advances. Such an advance is in the making -..."**[27].

We have seen that as a nation we have not done well in planning logistic support for the future battlefield. Without anticipating the future we have entered into war without the command and control structures and equipment to supply our combat forces. The result has been casualties and hardship on the front line soldiers who paid for the time to generate a battlefield logistics system. When we have anticipated the future, it has resulted in logistics preparedness, even when our vision of the future was somewhat flawed. Today's vision of the future battlefield likewise is blurry but worth refining into a concept that can be used as a basis for building our battlefield logistics systems for the future.

Future Battle

Understanding the nature of the future battlefield is crucial in structuring logistics forces to support it. Rarely has the need for insight into the future been so great as it is today. Few wars in the past have moved at the tempo that we can expect in future wars. This speed will preclude major adjustments to logistics force structure, doctrine and equipment during the conflict. Therefore if we are not prepared for the future and its battles when they arrive, it may be too late to change.

Difficulty of Predicting the Future

The term "future battle" brings many images to mind; from F-117 Stealth Bombers and Patriot Missile Systems, to directed energy systems, "Buck Rogers" and "Star Wars". In this monograph, future battle encompasses approximately the time span from the year 2000 to 2023. To put this in prospective, it is as if we were trying to peer at today from 1963, to determine what the nature of combat would be like through the 1970's '80's and into the '90's. In some ways, this may look like a highly speculative task. It is possible. For example thirty years ago (in 1963) one could predict much about how the world would look today. In 1963 the first woman flew in space, the first James Bond movie "Dr. No" was released, and the X-15 experimental aircraft set a sixty seven mile altitude record. In the military, it was one year before the Gulf of Tonkin Resolution that escalated U.S. involvement in Vietnam, the F4, A6, C141 and B52 aircraft were flying (all of which are still in service and flew in the Gulf War). M113s were our new armored personnel carrier and soldiers were soon to be equipped with the M16 rifle. Many things have not changed in 30 years.

The attempt to peer into the future is in no way new. Jean De Bloch, in writing *The Future of War,* predicted much of the nature of battle in World War I,

which was to occur more than fifteen years later. In spite of his inaccurate assessments on man's response to this violent coming war he was able to envision the basic nature of its battlefields. With this in mind, one can examine future battlefields in terms of the conditions and technologies operating there that will define its nature.

Nature of the Future Battlefield

> **Overhead, Remotely Piloted Vehicles (RPVs) pass back and forth over the battlefield unheard and undetected by the human eye. Some carry sensors with a god's eye view of the battlefield. Others loiter like hawks awaiting their prey. Higher still are unblinking satellites. Systems peer with millimeter radar through clouds and camouflage to reveal what is hidden. In real time powerful computers compare previous images and electronic emissions with new ones to track the movement of threat systems over the terrain. To the untrained observer the battlefield appears empty with the exception of burning fires from exploded vehicles. To be seen or even sensed here is almost certain death. There is no front line behind which is safety. Brilliant weapon systems impact hundreds of kilometers behind the forward troops destroying ports, logistics and reserves. Three armored vehicles start their engines and begin to move. Before they have gone 100 meters blazing fires, fed by liquid propellant, rage from the open hatches. Internal explosions complete the destruction wrought by an unseen enemy.**

What, exactly, the future battlefield will look like is, in many ways, an enigma. The ability to predict individual nuances of future battle certainly does not exist. "Writing on war in the future in these fast-moving times, is like describing a game in which the goal posts are moved every day and the rules changed every night."[28] There are, however, undeniable trends that have developed over many years that, with relative assurance, will continue in the foreseeable future. These trends indicate that the future battlefield will be larger, deeper, faster paced, and more lethal than any we have known in the past.

Lethality and Dispersion

The lethality of combat forces has increased at an exponential rate (figure 1). The combat brigade of the early 1980's had the equivalent combat power of a World War II division with one sixth of the manpower.[29] Today, a battalion sized unit can mass that same combat power, an increase of 1800% in a half century. More important than the tons of lead and iron armies can throw is the accuracy with which it is delivered. No one can argue that today's M1 rifle is not a more lethal weapon than the musket used by Napoleon's Grande Armie. Yet in spite of this increase in lethality, the rifle today causes fewer casualties than the musket of the Napoleonic Wars.[30]

The increasing lethality of weapons has not resulted in a corresponding increase in the number of casualties (figure 1).[31] This phenomenon is caused by the inverse relationship of countermeasures to the increased lethality. One counter to increased lethality is to decrease the number of targets available on the battlefield that your opponent can hit. Thus as lethality on the battlefield increases, it forces soldiers and combat systems to disperse and adapt for survival.

In the face of rising weapons lethality, concentrations of troops on the battlefield have become not only less effective but actually counterproductive, providing more targets for the enemy, resulting in greater casualties.[32] Longer range weapons, more powerful and accurate fires increase the need for terrain to hide and protect forces. The result of these pressures are again greater dispersion of both the fighting force and its logistics support. This change is dramatically portrayed by examining battlefields over time. In the Napoleonic Wars one hundred thousand soldiers occupied just over eight square miles in battle. In comparison the World

War II battlefield seems almost empty with the same number of soldiers occupying one thousand seven hundred and twenty seven square miles.[33]

This "empty" lethal battlefield multiplies the problems of the logistician. The battlefield continues to expand because of increasing lethality. In spite of the increased lethality, logisticians, with very limited amounts of protection, must continue to operate on the battlefield to supply combat forces. To survive, weapons systems are spaced farther apart on the terrain. Logisticians, in response, must then travel farther on a more deadly battlefield in order to re-supply our forces. The time and distance which logistics forces are exposed to enemy fires continue to become greater for weapon system re-supply. This increase magnifies command and control problems for the logistics commander and reduces the responsiveness of the logistics system to changes in operational requirements.

Future Battle Systems

In addition to using trends from the past, Army studies on future battle provide additional resolution to our picture of the future. One such study is the U.S. Army Training and Doctrine Command's (TRADOC) future war fighting concept called Airland Battle-Future. This study projects that the future battlefield will capitalize on non-linear warfare, intelligence systems, and longer range lethal weapons. It also shows that U.S. forces must move more quickly on the battlefield and be able to sustain continuous combat operations for as long as twenty four hours before there is a break in the action. A summary of some of the major pressures affecting the nature of the future battlefield is shown below.[34]

Pressures on the Future Battlefield

INCREASING	DECREASING
⇑ WEAPONS COST	⇓ WEAPONS NUMBERS
⇑ WEAPONS COMPLEXITY	⇓ BUDGETS
⇑ LETHALITY	⇓ NUMBER OF UNITS
⇑ RANGE	⇓ BATTLEFIELD DENSITY
⇑ ACCURACY	⇓ MILITARY AGE POOL
⇑⇑ SENSOR CAPABILITY	

If you look at this table from a logistics systems approach it means the following. Fewer people will have to supply limited numbers of complex and expensive weapons systems with the food, fuel, ammunition and maintenance support they need to operate. They will be greatly dispersed and have to be supplied over a greater distance than ever before. The re-supply will take place on a battlefield where enemy weapon systems can sense your presence, target you and deliver fires from distances never before possible with greater accuracy and more devastating results. This greatly increases the risk for the logistician in his or her thin skinned fuel tanker or ammunition truck. Other studies have examined the future battlefield in even greater depth.

In a separate effort, the Assistant Secretary of the Army for Research, Development and Acquisition commissioned a comprehensive review to address battlefield technologies of the next thirty years. The Committee on Strategic Technologies for the Army of the Twenty-First Century (STAR 21) was formed to study the issue. Included, among the members of the twenty five committees that

formed the board, were an impressive array of experts from science, industry, education and government.[35] The results of this study are compiled in The STAR Report. Many key technologies and systems were listed in the report as having dramatic impact on the future battlefield. Among those technologies, the following, when developed, will directly influence the battlefield delivery of logistics support. These key areas are: brilliant munitions, robotics, sensors, communications/electronics/surveillance, and stealth.

Brilliant Munitions

Brilliant munitions provide a quantum leap in the increased lethality of weapons. This change in lethality influences the ability to provide protection to logistics on the future battlefield. Brilliant weapons systems differ from current "smart" weapons. Smart weapons are guided to hit a particular target or to attack in a specified way. Brilliant weapons are autonomous. On their own they detect, attack and destroy enemy systems. Because of their independent targeting capability, brilliant weapons are ideal for long range use against both soft and hard targets.

Current smart and dumb delivery systems including artillery, aircraft, remotely piloted vehicles (RPV) and missiles can emplace brilliant munitions to the rear of combat forces in its logistics tail. One example of a first generation intelligent munitions is the Brilliant Anti-Armor Submunition (BAT) which detects and destroys tanks and other moving vehicles using acoustic and infrared sensors.[36] BAT munitions are currently in the final developmental stage prior to production. Similar brilliant munitions could be employed in enemy drones to interdict friendly supply lines. These drones could range hundreds of kilometers deep, using inertial guidance, terrain mapping or Global Positioning System (GPS) for guidance.

This threat can easily kill soft sided logistics vehicles loaded with fuel, ammunition and other supplies. In restricted terrain or undeveloped theaters the enemy could determine from a map where critical logistics supply routes and nodes would be and could attack them using these brilliant weapons. In a broader theater, just a few rudimentary sensors would enable an enemy to determine where main supply routes were and execute attacks against logistics in depth. From off of the road brilliant mines could even target particular types of vehicles like ammunition or fuel carriers to cripple a particular portion of the supply system.

Robotics

Robotics are just now entering into a useful stage of development for battlefield use. Robotic vehicles and weapons will take the place of manned systems in some of the more dangerous jobs on the battlefield as they have in the civilian sector among bomb squads and in nuclear and chemical processing plants. While we currently lag some other countries in this application of technology it will become a part of our military apparatus. It has been said that "War is always an equation of men and machines. Efficiency comes of a proper balancing of the equation."[37] Americans have always preferred the equation to be balanced more on the machine side than on the man side. Our social values that treasure human life make the U.S. willing to expend money and material where it will save a soldier's life.

Battlefield robots will not look like humans, as popular television and movies portray them. Robots that will truly walk and run are not expected to be economically feasible until approximately the year 2020.[38] Even then, manned systems may be more effective than robots because of the complex dynamics of the battlefield. What we may see though, is a blend of robotic and manned systems,

with exoskeleton machines to give infantry soldiers superhuman strength and endurance.[39]

Robotics will first be seen operating equipment we already know. Simple robots today can control a Unmanned Aerial Vehicle (UAV) in flight, pick inventory for shipping and handle hazardous materials. In the future light infantry units may receive robot helper systems that would follow soldiers into battle with re-supply and "could be controlled by voice and perhaps eye movement"[40] of the operator.

Significant manpower reductions could be achieved in the logistics arena with robots for transloading and hauling equipment and supplies. Existing technologies developed by the auto industry and commercial warehousing would make a robotic wagon train for combat re-supply possible in the near future.

> **The battalion supply sergeant drives his armored HUMVEE through the dispersed supply point. On the back of his vehicle is a thermal placard that identifies his battalion. Without stopping he wanders along a pathway identified by a list of grid designations inputted by radio to his GPS receiver. As he crosses off each checkpoint a flat bodied platform loaded with cargo joins the train forming behind his vehicle and trails it with its passive forward looking infra-red system (FLIR). As he passes each "mule" hidden among the terrain he reads the transmission off the radio data tag that lists the contents of the carrier. As the convoy passes points near the battalion individual mules begin to drop from the convoy with their pre configured loads. Using their onboard guidance the mules maneuver to the final location for re-supply passed to them over the Inter-Vehicle Information System (IVIS). When empty, the platforms return to a pick-up point and follow the next manned vehicle back to reload. Built in self defense programs disburse the vehicles into hide positions, upon receiving an air threat alert broadcast.**

Robotics offer three distinct advantages for logistics operations. First, it is capable of continuous operation on a lethal battlefield. Unlike soldiers, machines would require little down time and could operate on contaminated battlefields. Second, robotics frees equipment designers from manprint requirements. Robotic

vehicles do not require the human comfort and survivability measures that restrict vehicle design and increase the vehicles size. Lastly robotics allow logistics units to surge twenty four hour operations and increase capabilities without increasing personnel. This reduces the likelihood of casualties in lightly armored logistics areas. Use of automation technology to control the robots offers an additional benefit of increasing flexibility in the logistics system. Real time instructions to robotic re-supply vehicles can redirect logistics priorities to influence the outcome of engagements and battles. This coordination will be enabled, in part, by the increase in capabilities in the electromagnetic spectrum.

Communications/Electronics/Surveillance

Changes to communications, electronics, and surveillance systems will have a significant impact on the future battlefield. Future space based systems will relay intelligence information directly to the battlefield.[41] Current resolutions, of under one foot for photographs,[42] and less than seven feet for radar imaging,[43] will improve to provide ground forces with real time tracking of enemy systems down to the soldier level. One big change will be the availability of space products which will be available in almost real time down to battalion and perhaps company level and below. Proliferation of imaging systems will provide near-continuous wide area surveillance.[44] This flood of information from "the ultimate high ground" changes the nature of the future battlefield by:[45]

- eliminating horizons which now provide concealment,
- eliminating sanctuaries now out of the reach of enemy weapons,
- increasing the size of the battlefield to potentially global proportions.

Satellites are not the only sensors that will provide information to the battlefield. Reconnaissance aircraft, JSTAR's, RPVs, radar's, signal collectors, and

other systems will be knit into a seamless blanket of intelligence collection that will cover the battlefield.[46] This information will be available throughout the battlefield using systems like the All Source Analysis System (ASAS)[47] or through a more distributed system like the Integrated Vehicular Information System (IVIS). Either system would generate near real time information on enemy dispositions and capabilities. Information will be passed on new generation communication equipment which will reach terahertz speeds (one trillion hertz per second) and will switch signals in picoseconds. This thousand fold increase over today's fastest communications (currently around one gigahertz or billionth of a second) is expected by the year 2020.[48]

For the logistician this increase in communications capabilities will provide a trickle down effect into the logistics systems. As the battlefield becomes more integrated through communications networks, logistics systems will be integrated on the battlefield communications nets. For the first time most logistics elements will be able to communicate in real time. Supported units will be able to pass support requirements and locations directly to the logistics elements providing them support, while they are on the move. As the U.S. military increases its capabilities in the electromagnetic spectrum so do its enemies. To defeat their new capabilities countermeasures must be implemented.

Stealth

To evade the unblinking eyes scanning the battlefield, stealth technologies will be integrated into vehicles, weapons systems and even soldier's garments. Radar absorbing materials, new designs for reduced signature, as well as decoys, image projection devices and camouflage will continue to improve. Ballistic clothing woven with advanced fibers will resist low velocity fragments that would

have produced casualties in any other war. These measures will not eliminate the ability of enemy sensors to determine the location of friendly weapons systems. But, they will require more effort to target the same systems that could be easily detected today.

For logistics vehicles this may mean smaller vehicles with less carrying capacity to meet the stealth design requirements. Countermeasures and armor protection either built in or added on as modules will further reduce the carrying capacity of logistics vehicles. Robotic systems will be easier to adapt than manned systems because of the increased freedom to alter designs that do not need to accommodate human needs. Ballistic fibers and packing will increase the protection available to logistic cargoes without increasing bulk. To meet some of these new challenges on the future battlefield several new logistics system have been or are being fielded.

New Logistics Technologies

Several technologies can be integrated into U.S. Army logistics support units that will impact operations in the near future. Each of these new technologies brings increased capabilities to our logistics system. These technologies when used together interact with each other and provide a synergistic effect which changes the way we should think about logistics at the unit level.

The Global Positioning System (GPS) is not a logistics system but it influences logistics operations in several ways. GPS is a small satellite receiver that triangulates the users position using several satellites simultaneously to determine location and altitude to accuracy within a few meters. GPS enabled VII Corps to conduct the "Hail Mary" play through the trackless Iraqi desert during the Gulf War.[49] GPS technology is being imbedded into weapon guidance systems to

increase accuracy for long range fires. This technology is adaptable by all nations with limited cost involved. This deep targeting capability creates a significant threat to logistics activities.

GPS is also being integrated into other systems including aircraft and missile systems. One possibility is a GPS receiver that is integrated with: a compact disk player using digital map data, a digital radio, and a video screen could identify your location and track your position and the positions of units or vehicles you are to support. Radar maps from satellites could provide details of micro terrain so movements could be pre-rehearsed using inter-visibility lines to limit exposure to enemy fire and reconnaissance systems. Intelligence information could also be passed through this same system to identify safe routes for logistics trains to travel. GPS integrated into vehicles will allow robotic vehicles to determine vehicle and route locations and may eliminate the need for internal guidance and active measures to determine vehicle location.

The Palletized Loading System (PLS) is currently being fielded to carry ammunition on the battlefield. PLS uses a large flatrack carried on a high mobility chassis to deliver supplies to the battlefield. Advanced material handling technologies allow a single operator to rapidly deliver and unload both truck and trailer loads of ammunition. PLS vehicles are easily adaptable to class III and IV requirements as well, allowing the prepositioning of fuel and barrier materiel for defensive operations. The use of GPS to survey supply drop sites allows easy recovery or location of stocks by combat units falling in on a prestocked defensive position. The increased mobility of PLS also expands the terrain envelope in which responsive logistics can be provided.

Self diagnostic equipment is currently imbedded in many of our new systems. This technology identifies equipment faults without the need of external

testing equipment. The technology is also used in many production cars to indicate required services to vehicle owners or to alert them of problems with engine operation. The front edge of this technology is used in very large scale integrated computer processing chips. These chips can detect when a circuit is beginning to fail and switch the function of the failing circuit to a redundant path etched on the same chip. In effect these systems are repairing themselves[50]. Self diagnostic equipment on the battlefield will allow maintenance personnel to know what is wrong with systems so that when they arrive on the scene they can have the parts needed to make the system operational. This will also aid in performing equipment triage to determine which equipment should be abandoned because of multiple faults that cannot be corrected in time to affect the battle. Eventually this diagnostic system will be able to detect many failures before they become catastrophic and automatically switch to standby systems.

Development of technologies for other areas of the battlefield impact on how logistics will be applied at the pointy end of the spear. One system under development that could be revolutionary for logistics is the Integrated Vehicular Information System (IVIS). IVIS is one of the first steps to digitizing the battlefield. This digital processing system receives and transmits data about friendly and enemy forces to each vehicle equipped with IVIS. The IVIS display (figure 6) shows friendly and enemy force positions, logistics status, battlefield graphics and communicates standard reports of action, such as rounds fired, automatically. IVIS and similar technology is a revolutionary system that could transform the way we conduct both battle and re-supply on the battlefield. With an IVIS equipped tank brigade a brigade commander could skip echelon down to the individual tank level to communicate an immediate change to a plan. Logisticians could manage logistics based on actual consumption reported in near real time. Instead of creating large

targets on the battlefield where unit LOGPACKs link-up for supply distributed operations could accomplish the same results. Roving logistics vehicles could identify combat vehicles requiring fuel and their location. GPS and IVIS interfacing with digitized terrain maps could plot the safest and fastest routes to the vehicle needing supplies. Both the supply and combat vehicle would show up on the display allowing supply operations to continue without establishing formal supply sites vulnerable to attack. Critical assets could thus be employed more effectively to weight the battle.

Assured communications is a prerequisite to allow IVIS to function. New generation radios with multiple band capability and frequency hopping circuits will allow higher levels of data transmission than ever possible before. With the higher levels of data throughput, commanders will achieve a better picture of what the battlefield looks like. Some of this information will assist logisticians in delivering continuous logistics that is more finely tuned to the needs of the combat commander. Satellite communications will enable widely spread logistics units to communicate during the performance of the mission as never before. These tremendous changes for the future, when taken together, demand a new system of logistics support based on information technology and not just another modification to the current system that has its foundation in the industrial and pre industrial age.

Current Logistics

The current system for logistics support has changed in an evolutionary manner from the armies in the American Revolutionary War. While these changes have resulted in improvements they do not enable the current system to function adequately in the future environment that has just been described. To understand why, we must first examine the current structure for support. The supply of class III

(fuel), class V (ammunition), class I (food), along with medical and maintenance support are some of the most challenging logistics problems for combat units today. These, and the other supplies and services necessary to maintain companies and task forces in war, are moved to the combat unit by combat trains and Logistics Packages (LOGPACKs), pushed forward from the field trains as often as three times a day. The combat trains make up the most forward element of the current logistics system. Normally, the company's first sergeant is responsible for controlling the operation of the company's combat trains.[51] To protect these unarmored logistics vehicles, combat trains are kept approximately 500 to 1000 meters away (one or more terrain features back) from the company battle positions if possible.

Re-supply of combat units can be done by bringing elements of the field trains forward to the company in a LOGPACK. A typical LOGPACK for a tank company would have: a supply truck, fuel trucks, ammunition trucks, and other vehicles as needed to carry supplies or perform maintenance.[52] Command and control in the LOGPACKs normally provide one noncommissioned officer for every two to four enlisted soldiers. This high ratio of first line leaders ensures the delivery of each class of supply to the task force. This type of vertical organizational structure has advantages in providing a high level of direct leadership and moral courage to troops through direct face to face contact.

Units in direct contact with the enemy provide protection for their own combat trains as required. However, the light protection afforded to the combat trains' vehicles and their lack of firepower makes them a weak link in the armored task force. This link must survive the heat of the future battlefield if U.S. Army forces are to fight and win.

There are several weaknesses in this system. The current system depends on security being provided by a somewhat linear front to protect logistics assets. This

front places fifteen to thirty kilometers between the front line of friendly troops and large logistics targets (i.e. the Brigade Support Area (BSA)).[53] In future war it is likely to be non-linear and dispersed on the battlefield. The distance of thirty kilometers provide little protection to soft targets that are readily identified with enemy sensors. Without protection the logistics base concept must be discarded.

The current system also is designed to work best in a static situation rather than a highly mobile operation. The requirement for someone to meet the combat trains and direct them to where they are going is extremely difficult to do if the force you are supporting is also on the move. This link-up currently assumes a relatively uninformed vehicle and operator that is met by the informed or smart supervisor who becomes the critical node in the system. Missed link-ups, confused coordination and lost or misdirected convoy's are all symptoms of the current reliance on a single key supervisor rather than a distributed network of support.

Perhaps the greatest weakness of the current system is the target that it provides to enemy forces equipped with future systems. Company LOGPACKs while re-supplying can present a target as large as be as large as ten or more vehicles[54]. Battalion trains are often as many as twenty vehicles and the BSA routinely has well over one hundred vehicles which present a lucrative target to enemy weapons systems. The lethality and range of weapons and sensors will not allow this type of congregation of vehicles and systems without heavy losses. Weapons systems currently available to logistics forces are mostly small arms and machine guns and can do little to counter this type of threat.

The present supply system is tied to a relatively set schedule. Unit operating procedures direct how often LOGPACKs will be pushed forward. This requires LOGPACKs to be based on the system with the shortest endurance. Currently this is the M1 tank in an armored task force which requires fuel approximately every eight

hours. Other vehicles with the task force must move to the fuel point every eight hours, exposing them to enemy fires if they are in the defensive even if they only need fuel every twelve or fifteen hours. If they do not have at least twice the endurance of the M1 they must refuel when it needs fuel. This does not utilize the full capabilities of the other combat systems, slows the tempo of their operations and exposes them to unnecessary enemy fires.

The expense in personnel is the last factor in which the current system of logistics re-supply is unacceptable. Because logistics systems have trailed in development behind other battlefield systems they have relied upon low technology systems to accomplish their mission. For many years face to face coordination and using guides to lead logistics forces forward and back have been acceptable. Today less than half of the logistics vehicles have any type of radio to communicate with each other or to supported elements. Command and control structures have decreased the number of soldiers per sergeants to almost a one to one ratio (figures 3 and 4). This is needed not only to supervise but to; coordinate, provide each section with leadership, and direct vehicles to the proper link-up points. Technology is now able to replace many of these traditional methods with better processes for command and control of logistics forces on the future battlefield. If today's system of supply will not work then a better one must be constructed.

Future Logistics

"It is inescapable that logistics will play a predominant role in any future conflict.... The destruction of logistic potentials will be the primary objective of warfare, the defeat of combat forces in the field becoming a secondary consideration."[55]

Logistics Paradigm Shift

At some point in time the incremental changes to logistics operations we have experienced to date, resulting from faster, more mobile trucks, or new methods of passing requisitions, must give way to a more revolutionary change in the way logistics command and control operates on the battlefield. This change will occur when the battlefield becomes so lethal and changed in nature that it will no longer allow logistics to be provided under the old paradigm. A new model for logistics will replace our current doctrinal structure for logistics when:

-Sensors of enemy intelligence systems are able to track vehicle movement behind the forward edges of the battlefield.

-Lethal weapons tied to enemy sensors will not allow the concentration of vehicles in the forward combat zone without an engagement occurring.

-U.S. command and control systems are able to track friendly vehicle locations and logistics status.

These first two battlefield conditions will strip the current protection from logistics operations and destroy the ability of today's LOGPACK structure to provide logistics support to future combat teams. The third condition will facilitate a new logistics organization and support doctrine to operate under. A model for a future logistics system comes from nature. One of the logistician's jobs is to make the complicated look easy, like an ant gathering food.

It is amazing to watch the diligence of a colony of ants gathering food for the winter. Reposited in their simple bodies from the time of their creation, is the knowledge and skill that enables these tiny insects to move their equivalent of mountains through diligent effort and teamwork. I watched and pondered their industrious activity as I ate my lunch in the desert at the National Training Center. It was not long before the ants somehow became aware of my lunch and soon began reconnoitering the desert floor to discover its location. Not having

finished my lunch I diligently killed these reconnaissance forces before they could alert a main body. In spite of my best efforts the cache was found and soon the equivalent of an ant Main Supply Route (MSR) was set up to handle the traffic. At first I tried to kill them and made minor moves to deceive them but in the end they prevailed.[56]

Logistics Operations

Several aspects of this encounter have similarity to logistics on the future battlefield. First was the nature of the engagement. In terms of technology man had perfect intelligence with overhead surveillance and the ability to strike targets with deadly results. Second was the nature of the enemy. Rarely were there more than two ants massed together for a good target. They were able to follow some invisible trail through the trackless desert to find the lunch (their source of supply). They conducted a large re-supply effort through decentralized operations. Throughout this process no single ant was critical to the success of the mission. This was done with the apparent lack of leadership on the part of any ant. In spite of superior intelligence, firepower, and mobility the colony was able to re-supply. Logisticians must have that same ability on the future battlefield. Lieutenant General John H. Cushman (retired) provides us a wartime scenario of this kind of distributed logistics operation.

"Marine helicopters lifting battalions from USS Wasp into amphibious assault on the Critico beach and port need refueling. Wasp's decks are busy. The mission commander asks his screen, "Where is the nearest FARRP (forward area rearm/refuel point)?" It displays one location in the 101st Airborne Division, another in the 82d, each with its current fuel status. Another display shows reported enemy locations en route. He refuels at both FARRPs and returns to action."[57]

Most of the equipment required to make the above scenario reality exists in the Army inventory or is being fielded. The one exception is the IVIS command and control system which is still under development. The following items exist in U.S. Army inventory and should be laterally integrated into logistics elements providing forward support to combat battalions and companies to increase their efficiency.

-Global Positioning System (GPS) receivers to coordinate rendezvous with vehicles and soldiers to be supplied.

-Night Vision Devices for nighttime driving and re-supply operations

-Map Displays on Compact Disk

-Area protection weapon like the MK-19 Grenade Launcher

-Assured communications with higher and supported elements.

-Inter-Vehicular Information System (IVIS)

IVIS, GPS, digitized maps and communications could be assembled together in a single package much like a modern portable stereo system that could be placed in any vehicle as needed. This package would allow logistics vehicles to swarm over the battlefield like ants. Refueling, rearming and maintenance would occur as needed on a distributed basis twenty four hours a day as the situation allows instead of having to fuel everyone during a limited window. This maximizes the use of logistics vehicles, weapons system capacities and provides the most continuous application of weapons systems.

Assured digitized communications, with supply vehicles, eliminates the need for a noncommissioned officer to chaperones to convoy vehicles to the right place on the battlefield. A single leader could manage as many as a dozen vehicles with two man crews using the same communication and information system with which the supply vehicles are equipped. Controlling the priorities for these vehicles could be

easy, using a touch sensitive screen, one could identify the priority vehicles for re-supply with the touch of a finger. Routes could be specified on the IVIS display by simply tracing a route with a finger or pen. Instructions could be passed automatically to the nearest logistics vehicle with the required supplies along with a recommended route for the fastest safe travel.

Logistics Implications

Logistics Structure and Protection

Logistics protection in the future will require distributed operations that have no apparent hubs, nodes or critical command and control centers. What is implied here is that logistics support must be provided without exposing a logistics vulnerability or center of gravity. Through dispersion, the logistics center of gravity becomes as difficult to strike as a smoke screen.

Logistics on the future battlefield must not be able to be pinpointed by the enemy. It cannot be tied to any fixed place. The image that must be portrayed to the enemy commander is that of a continually moving mass almost impossible to strike, like the electrons of an atom. On the future battlefield that this study has painted, fixed targets are not survivable without a tremendous expenditure in hardening or through expensive active defensive systems. Logistics vehicles by their nature are relatively large in comparison with combat systems and are difficult to protect with armor or protective forces. Key immobile facilities will require the lion's share of these types of defensive measures. The remainder of the logistics systems needs to become like an amorphous mass that conforms to the shape of each battlefield. It becomes, and at the same time, is everywhere and no where.

Part of being amorphous is the lack of individual identity. With the lack of identity comes a loss of value. If the enemy commander cannot identify key nodes

or points in the logistics system they cease to be high value targets. Therefore, to survive, tomorrow's logistics structure must become distributed in both organization and in function. Instead of single nodes serving task forces, the battlefield must have multiple nodes with alternate routes and flexible chains of command that provide redundancy and are capable of skip echelon control.[58] This matrix type structure eliminates the huge logistics activities that signal friendly intentions and locations (figure 5)

Matrix Logistics

Linear logistics, based on lines of communications, must be replaced with matrix logistics with multi-nodal distributed operations. To accomplish this, command and control structures must make a fundamental change. "A self managing network with fewer levels"[59] provides the kind of dynamic flexibility that could survive the intense pressure of the future battlefield. This type of network would have numerous advantages. Without a traditional vertical chain with multiple layers of intermediate leaders, friction is reduced. With the reduction of these layers of control, the extra steps in the process of issuing commands and having them translated by each level leader are bypassed, allowing the friendly logistics commander to be more responsive to actions on the battlefield. This increase in speed reduces the time of the decision cycle, allowing U.S. forces to react more quickly than the enemy.

Without special equipment or knowledge at each level the system is able to continue operating, regardless of which node is lost. Immediately, the system is able to begin compensating for loss because both the loss is known and what assets remain can concentrate on the most critical part of the mission. Without a traditional linear structure, this system is able to respond in any direction. Each vehicle is able

to operate independently because of the integrated radios and navigation equipment. The ground force logistics team assumes some of the attributes of air logistics re-supply. Ground logistics becomes as responsive to the commander's priorities and changing needs as his other components are.

Without the linear structure the logistics tail can orient on a new attack direction as rapidly as the maneuver force. This will provide continuous forward logistics under the most dynamic and changing battlefield conditions ever.

Stealth Logistics

Logistics protection also requires that logistics support operations must become less observable. Some advancements in this arena can be made through the application of stealth technology to logistics equipment. Trucks built with stealth technology may be required, to move, unmolested, under the watch of new sensors like those seen in the Gulf War. Additional reductions in the logistics signature on the battlefield can be made through the increased distribution of operations. Instead of massive fuel farms and ammunition dumps, future support bases must be widely distributed to take every advantage of terrain and mobility routes.

Post Script Precautions

Distributed operations provide protection from detection and reduce the value of a single site as a target for expensive long range weapons systems. A caution that must be considered is that a matrix organization structure may increase some threats to logistics operations from guerrilla or special forces actions. Comprehensive protection measures must be developed to protect logistic capabilities. These measures should include arming logistics vehicles with modular weapons stations. These systems could be enhanced versions of the current MK-19

grenade launcher or autonomous combat robots developed to protect supply stocks and caches.

A final aspect that must be considered on the new battlefield is the impact of this cybernetic change on the moral domain of the soldier. Traditional wisdom advises not to place soldiers alone on the battlefield in supply or combat operations. These are legitimate concerns that must be considered. This proposal for the future puts two soldiers in each vehicle that operates almost independently on the battlefield. We may find that because of changes to our society in the past 50 years that our culture is able to handle that type of isolation. Special considerations may need to be taken into account in vehicle design that will mitigate the isolation of the future battlefield. One thing is clear however, that is that the future battlefield will not allow us to gather together in our traditional bases and survive the war.

Conclusion and Recommendations

This monograph clearly shows that the current command and control system for battlefield logistics operations will not perform adequately on the future battlefield. It also documents, in its findings, several characteristics that must be present in our future logistics command and control system if it is to provide a combat multiplier on the battlefield.

The findings show that on the future battlefield, logistics systems may face an enemy with satellite systems, improved sensors, better communications, and long range weapons systems. The combined effect of these systems creates a new environment that removes the protections from enemy attack, that provided security to logistics forces in the past. For logistics operations to survive on the future battlefield they must adapt to the new environment.

The findings also indicate that in the past the Army has constantly failed to adequately prepare for the logistical needs of the future battlefield. A different model of planning for the future should provide us a source of inspiration. The United States Marine Corps in the period prior to World War II provides an excellent example of adaptation in preparation for the future battlefield. The Marines were ready to meet the new challenges of amphibious warfare brought by World War II. Army combat forces and logistics units must make similar progress in this generation to ensure robust support operations for future combat.

Force developers designing logistics on the future battlefield will find the following recommendations useful as they design new logistics units, equipment and doctrine.

I. A new distributed command and control structure must be developed.

A. The traditional organizational model must be replaced with a more efficient paradigm with fewer layers.

B. Command and control enhancements for maneuver forces must be expanded to include logistics control.

C. Logistics operations must be decentralized and distributed throughout the battlefield in depth.

II. New logistics equipment must be developed and fielded to sustain operations on the future battlefield.

A. Robotics technology must be applied to logistics support applications. Low profile robotic systems can replace many manned vehicles for logistics operations. Robotics is one technology that in the future offers the ability to lower costs, reduce casualties and increase productivity.

B. Stealth technology should be applied in vehicle and equipment design as countermeasures to enemy surveillance systems.

C. Logistics vehicles should have integrated into the design countermeasures to enemy weapons systems. Independent defense and communications equipment will enable them to have a more active role in logistics protection.

These recommendations for the future structure of logistics on the battlefield provide the framework for a robust logistics capability at the tactical level. Along with the ongoing reforms to the other segments of the Army's logistics system, they will ensure continuous support to our combat forces for the next generation.

Annex 1 Definitions

Logistics: The fourth century B.C. Chinese General, Sun Tzu, describes logistics as simply the overseeing of supplies. A more modern definition is "the process of planning and executing the sustainment of forces in support of a military operation"[60] For this study, we are looking at the subset of "tactical logistics"; where war materiel is handed to those who use it. According to *FM 100-5* tactical logistics "...sustains the tactical commander's ability to fight battles and engagements....It provides the right support at the right time and place to units in the Combat Zone (CZ)."[61] That means, that the trucks made it to the right place, at the right time, safely, loaded with right materiel to arm, fix, fuel, man, move and sustain the combat task force.

Management: The science of obtaining efficiencies in operations.[62] Management utilizes resources to provide maximum output of the desired product. For logistics operations, management involves the scientific aspects required to get the right materiel to the right places at the right time. Logistics management conserves assets to weight the main effort and provide the force commander a combat multiplier.

Leadership: The art of influencing human behavior[63] to accomplish the mission by providing purpose, direction and motivation[64]. Leadership is a dynamic process that must address the fears and weaknesses of human beings. It involves communicating to soldiers the need for accomplishing the

mission, the standards of performance, and the will to accomplish all they are capable of.

War: In this study, war is narrowly defined as the level of armed conflict involving major mechanized and armored units (brigade size and greater). Other spectrums of conflict would have to be examined before applying the results of this study.

Future War: In this paper "Future War" is war, as defined above, involving U.S. ground forces in the next thirty years (between now and the year 2023).

Figure 1: Increasing Weapon Lethality

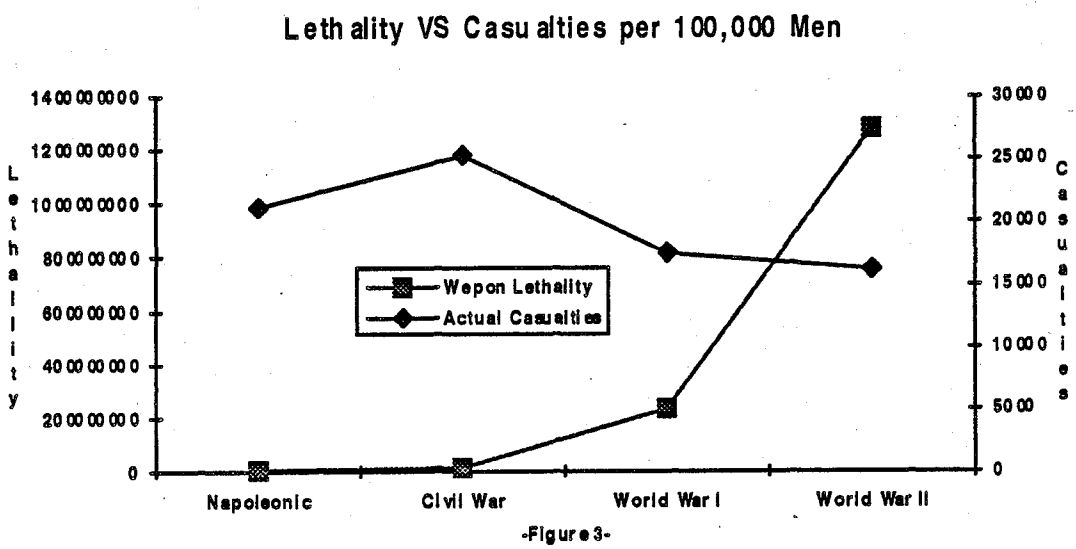

figure 1

Figure 2: Battlefield Dispersion

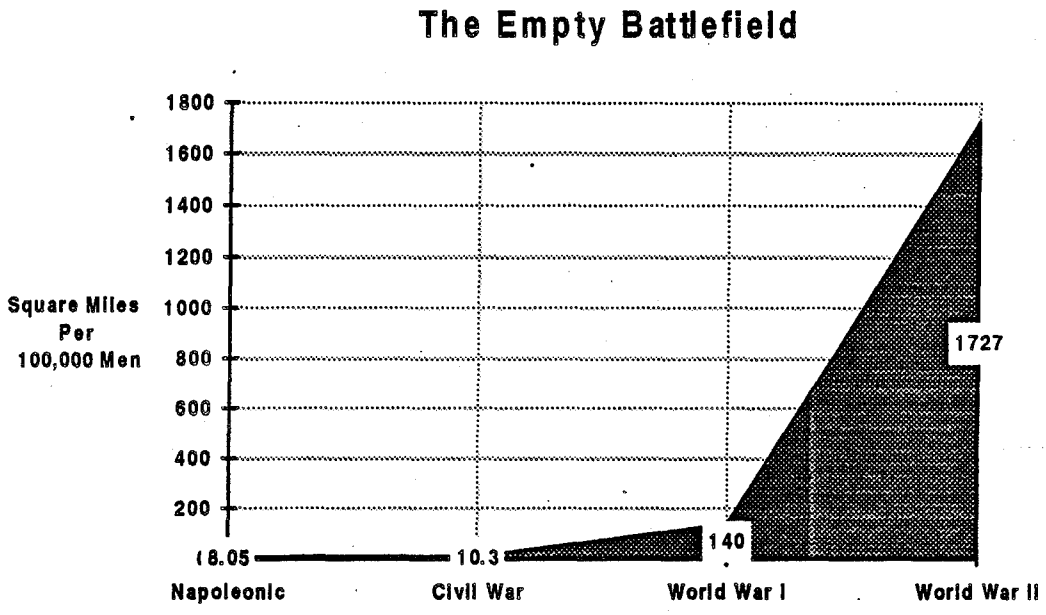

figure 2

Figure 3: Battlefield Logistics Leadership

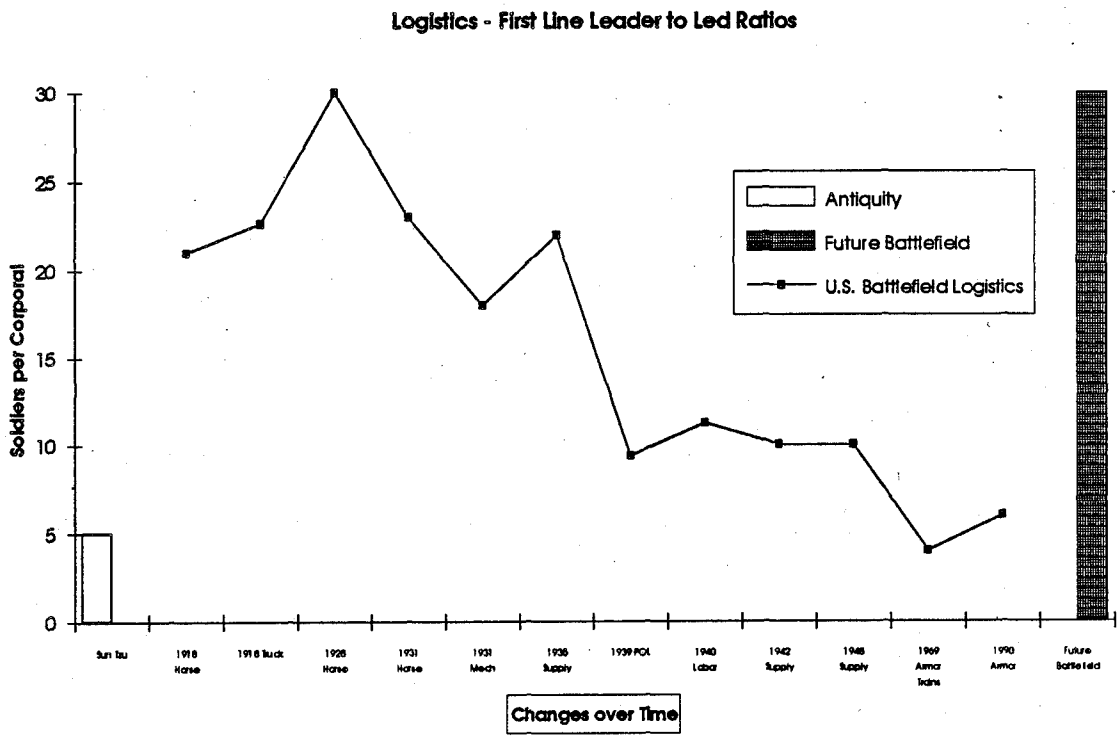

figure 3

Figure 4: Current Leadership Model

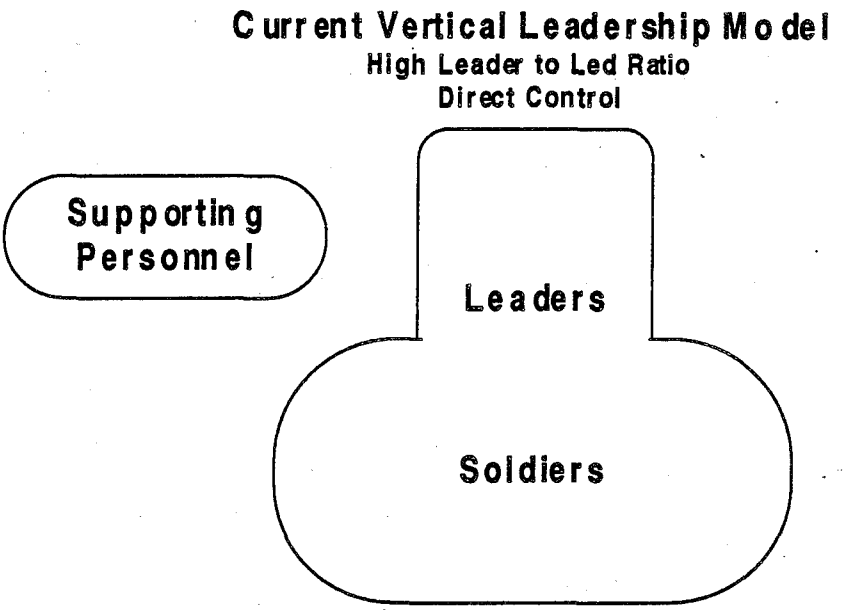

figure 4

Figure 5: Future Leadership Model

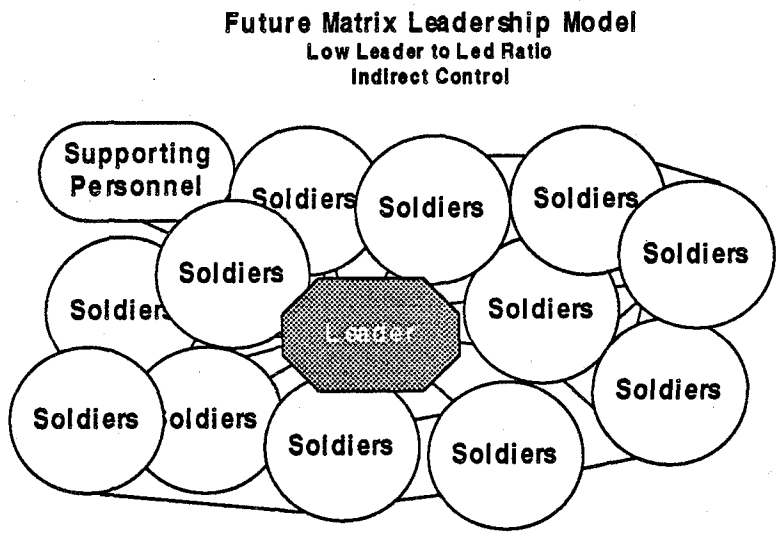

figure 5

Figure 6: Simulated IVIS Display

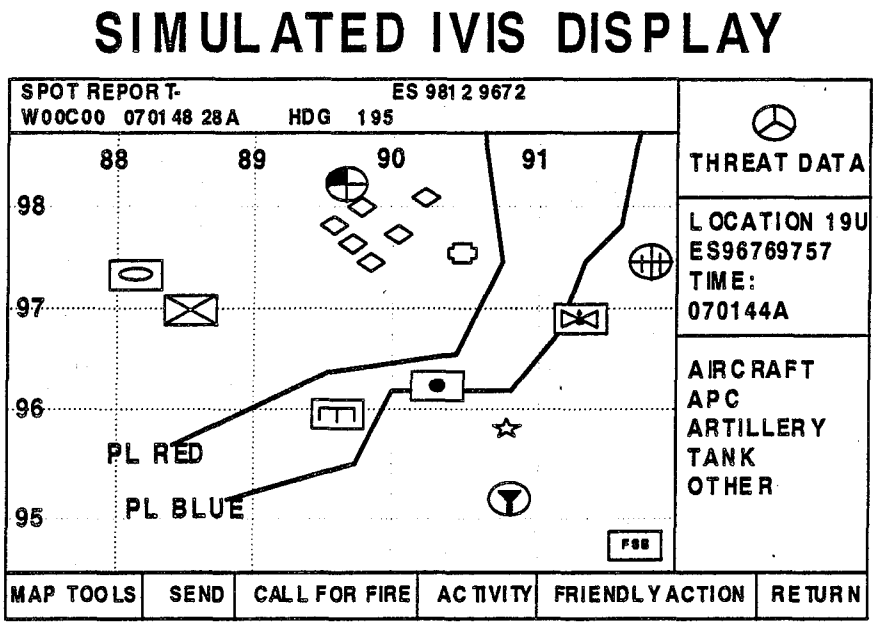

figure 6

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